(12) UK Patent Application (19) GB (11) 2 321 160 (13) A

(43) Date of A Publication 15.07.1998

(21) Application No 9625538.5

(22) Date of Filing 09.12.1996

(51) INT CL[6]
H04B 7/26

(52) UK CL (Edition P)
H4L LDGX L1H10

(56) Documents Cited
EP 0644702 A1 WO 94/10767 A1

(58) Field of Search
UK CL (Edition P) H4L LDGP LDGX, H4M MN
INT CL[6] H04B 7/212 7/26, H04J 3/16, H04Q 7/30 7/32 7/38
Online: WPI

(71) Applicant(s)
Nokia Mobile Phones Limited
(Incorporated in Finland)
P.O. Box 86, SF-24101 Salo, Finland

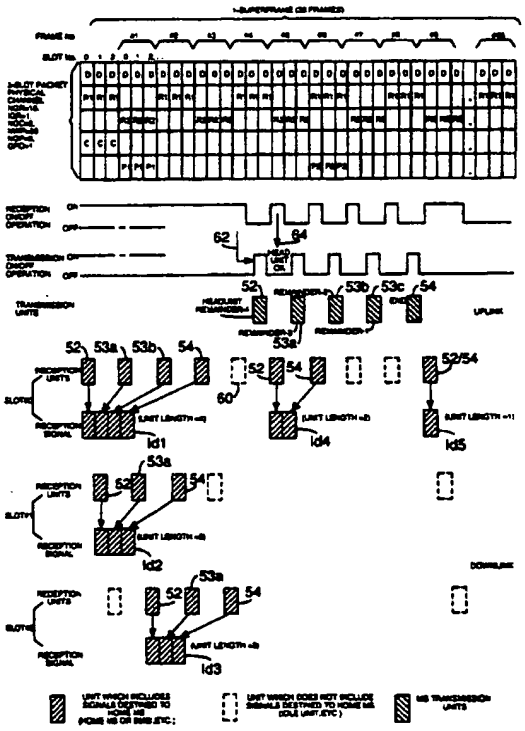
(72) Inventor(s)
Brian Chow

(74) Agent and/or Address for Service
Juliet Jane Grace Hibbert
Nokia Mobile Phones, St Georges Court,
St Georges Road, Camberley, SURREY, GU15 3QZ,
United Kingdom

(54) Abstract Title
**Adaptive TDMA communication system**

(57) Downlink communication between a base station and a mobile station occurs in a first format of more than one time slot of a time division multiplexed frame or a second format of one slot per frame when the mobile station performs an uplink transmission using the second format. Single or multiple slot per frame formats can be selected by the mobile station according to whether a high or low rate of data transmission is required. The uplink communication channel may be of the common access type, and both the uplink and downlink slots may be spaced in frequency and spaced in time by less than the duration of one slot.

Fig.4.





GB 2 321 160 A

Fig.1.

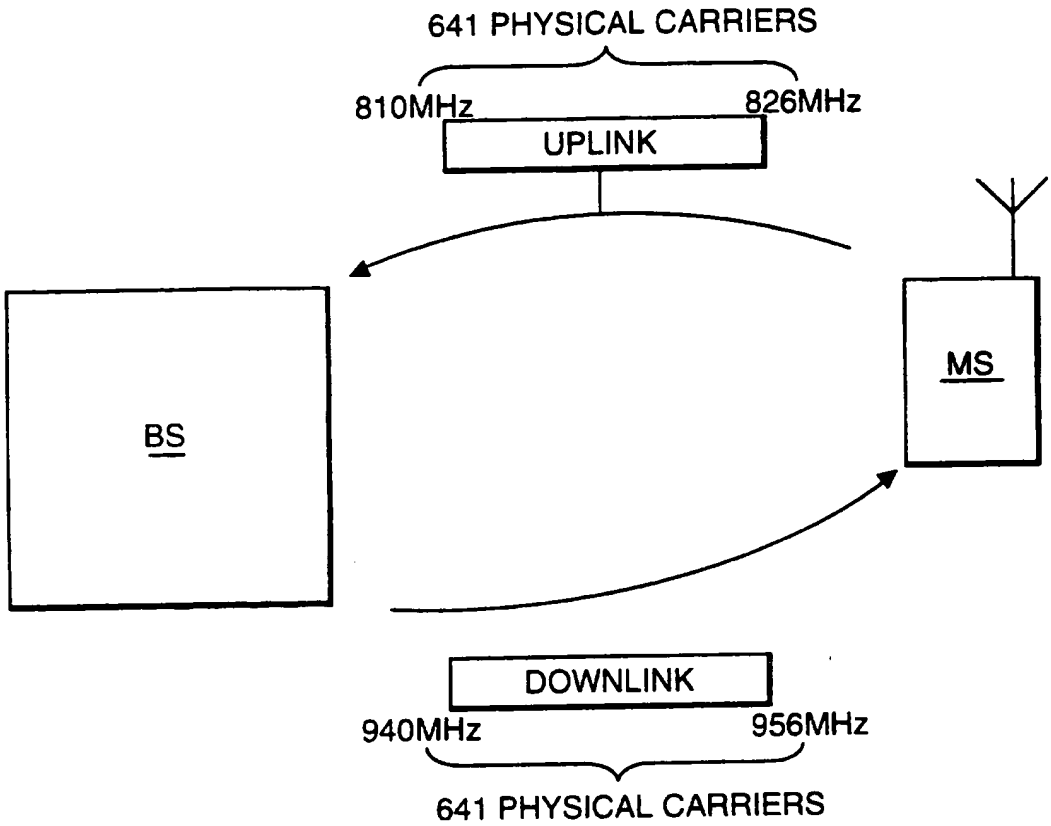

641 PHYSICAL CARRIERS
810MHz
826MHz
UPLINK
BS
MS
DOWNLINK
940MHz
956MHz
641 PHYSICAL CARRIERS

Fig.3.

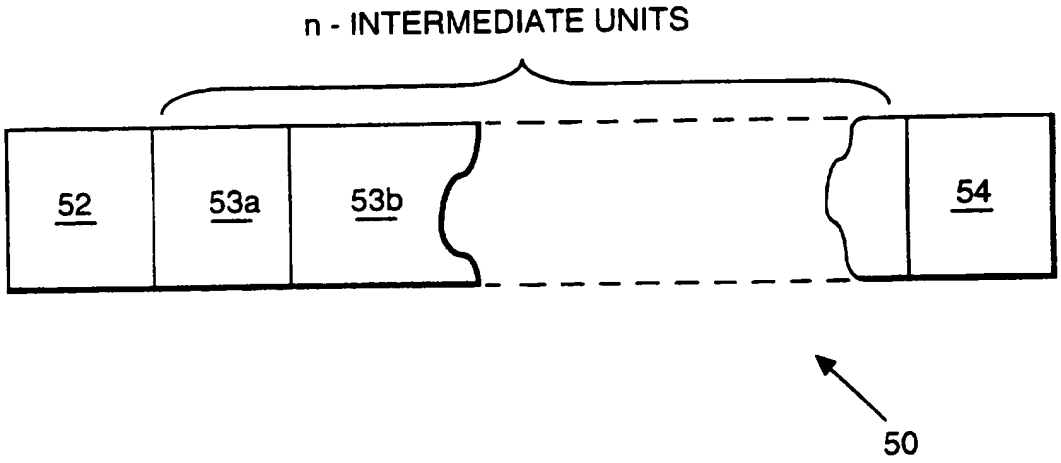
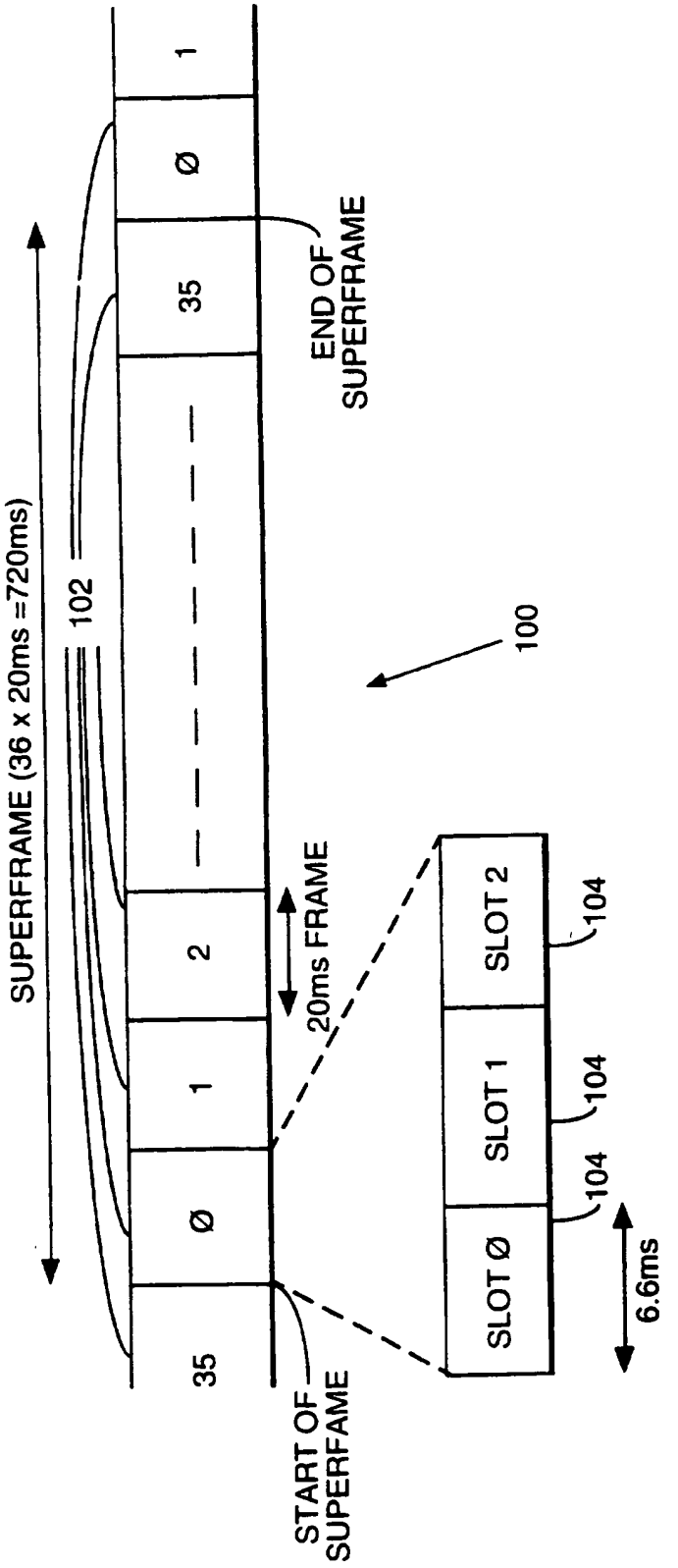
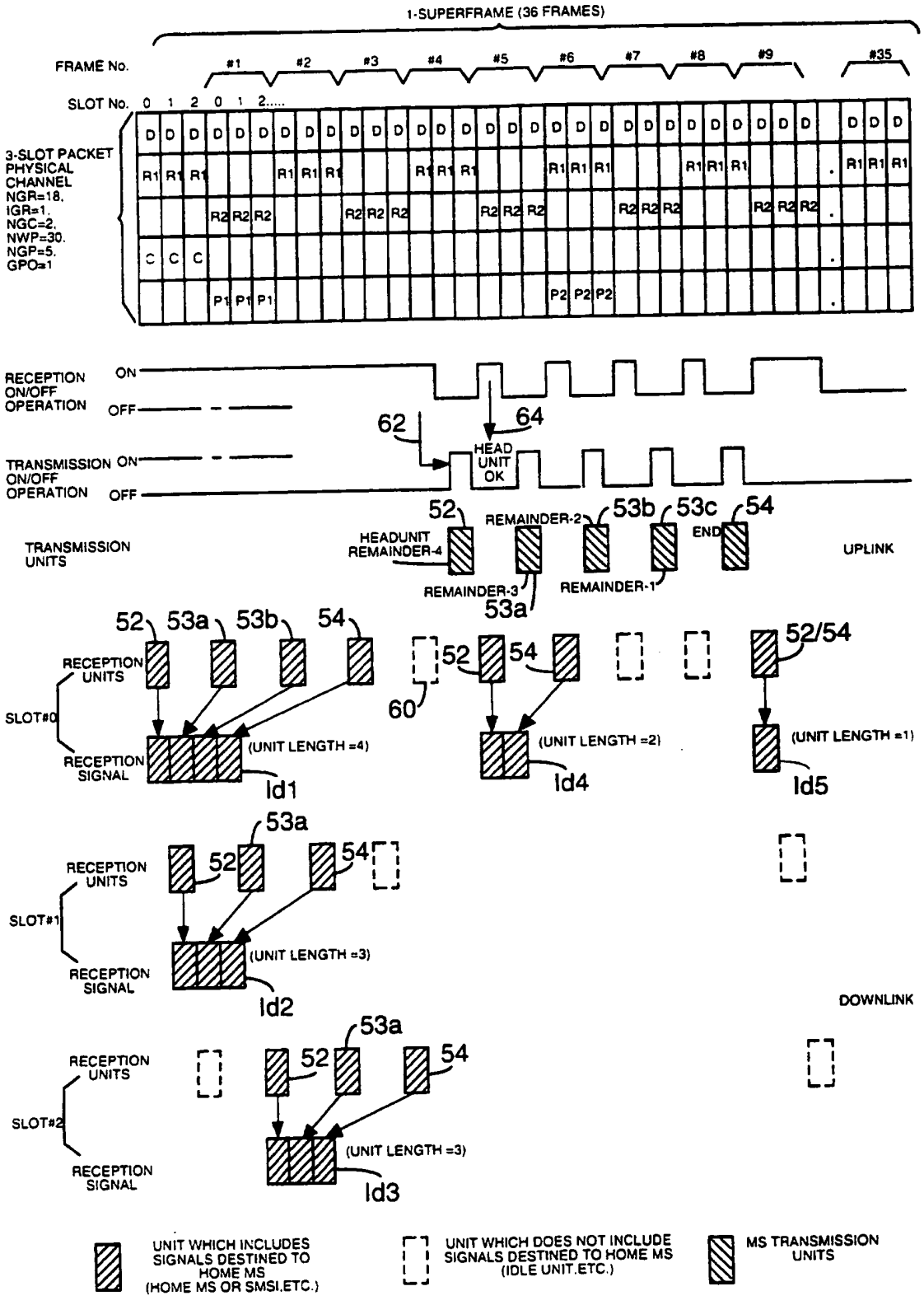

n - INTERMEDIATE UNITS
52
53a
53b
54
50

Fig.2.


SUPERFRAME (36 x 20ms =720ms)
102
START OF SUPERFRAME
END OF SUPERFRAME
35
Ø
1
2
20ms FRAME
100
SLOT Ø
SLOT 1
SLOT 2
104
104
104
6.6ms

# Fig.4.


1-SUPERFRAME (36 FRAMES)
FRAME No.
#1
#2
#3
#4
#5
#6
#7
#8
#9
#35
SLOT No. 0 1 2 0 1 2.....
3-SLOT PACKET PHYSICAL CHANNEL NGR=18, iGR=1, NGC=2, NWP=30, NGP=5, GPO=1
RECEPTION ON/OFF OPERATION
ON
OFF
TRANSMISSION ON/OFF OPERATION
ON
OFF
62
64
HEAD UNIT OK
TRANSMISSION UNITS
52
HEADUNIT REMAINDER-4
REMAINDER-3
53a
REMAINDER-2
REMAINDER-1
53b
53c
54
END
UPLINK
52
53a
53b
54
RECEPTION UNITS
SLOT#0
RECEPTION SIGNAL
(UNIT LENGTH =4)
Id1
60
52
54
(UNIT LENGTH =2)
Id4
52/54
(UNIT LENGTH =1)
Id5
53a
52
54
RECEPTION UNITS
SLOT#1
RECEPTION SIGNAL
(UNIT LENGTH =3)
Id2
DOWNLINK
53a
52
54
RECEPTION UNITS
SLOT#2
RECEPTION SIGNAL
(UNIT LENGTH =3)
Id3
UNIT WHICH INCLUDES SIGNALS DESTINED TO HOME MS (HOME MS OR SMSI.ETC.)
UNIT WHICH DOES NOT INCLUDE SIGNALS DESTINED TO HOME MS (IDLE UNIT.ETC.)
MS TRANSMISSION UNITS

2321160

# PACKET DATA

The present invention relates to packet data communication in a telecommunication system, especially but not exclusively the RCR-27 personal digital cellular system.

In a cellular telecommunication system comprising base stations and subscriber mobile stations, many packet transactions between the subscriber mobile stations and the base stations make very heavy use of the downlink but relatively light use of the uplink between the base stations and the mobile stations. Internet applications exemplify this since most data flow takes place from the Internet to the subscriber via the downlink.

With this consideration in mind, the present invention provides a method, and a telecommunication system, in which the format of a channel for packet communication is varied according to the nature of the packet transaction.

Within the confines of a given system protocol and the specific hardware of a system, this allows the telecommunication system to manage the characteristics of the packet channel to best suit its need.

Exemplary embodiments of the invention are hereinafter described with reference to the accompanying drawings, in which:

Figure 1 illustrates the frequency allocation in the 800 MHz frequency band in the RCR system;

Figure 2 illustrates the structure of a superframe in the RCR system;

Figure 3 shows the structure of an I-frame or layer 2 unit; and

Figure 4 shows an example of a packet transaction between a base station and a mobile station.

The Japanese RCR-27 personal digital cellular system is a Time Division Multiple Access (TDMA) system. An overview of the RCR-27 system is given below to facilitate understanding of the invention. For more details of how the system operates, the following standards specifications should be consulted: reference 1 - RCR STD-27D (Packet ver. Revisions) Layer1 Standards, and reference 2 - RCR STD-27D (Packet ver. Revisions) Layer3 Standards.

Communication between a base station BS and a mobile station MS takes place via two discrete frequency bands, one reserved for communications from the base station BS to the mobile station MS, the downlink, and one reserved for communication from the mobile station MS to the base station BS, the uplink, as illustrated in Figure 1. In the example in Figure 1, the downlink accommodates 641 physical carriers between 810 MHz and 826 MHz at 25 kHz intervals. For each physical carrier in the downlink, there is a corresponding physical carrier in the uplink. In the uplink, the physical carriers are also at 25 kHz intervals located between 940 MHz and 956 MHz.

Each physical carrier has data transmitted on it in the form of a superframe. Referring to Figure 2, each superframe 100 consists of 36 (0 . . . 35) frames of 20 ms duration and each frame 102 consists of three slots 104 (0 . . . 2) each of 6.6 ms duration. A superframe lasts 720 ms. Each frame can be assigned the role of either a user traffic channel TCH or a control channel CCH. The superframes in the uplink and downlink are transmitted with a small offset in time. The uplink control channels are common access whereby any mobile station MS can apply to the base station to use the channel at any opportunity.

In order to register with the base station BS, the mobile station MS scans a subset of the downlink physical carriers, which have been predefined by the network operator, as being perch channels. The signal strength on each perch channel is ascertained and arranged in signal strength order. Starting with the perch channel

having the strongest received signal strength, the mobile station MS attempts to synchronise and decode the data in slot 2 of the perch channel. This slot is assigned to a control channel, more particularly the broadcast control channel BCCH. The broadest control channel BCCH contains information about the cell or zone including, for example, the control channel structure, network identity, location area, neighbouring zones, restrictions on use and the like. The BCCH information also includes information indicating which slots have been reserved for the role of the user packet channel UPCH. This UPCH information is in the form of data indicating the physical carrier and the slot of the superframe transmitted on that physical carrier.

If the BCCH information is not decodable from the perch channel with the highest received signal strength, the mobile station MS tries the perch channel with the next highest received signal strength and so on.

Having decoded the BCCH information, the mobile station MS is able to make a request to be registered in the cell or zone. Having been registered with the base station BS, the MS station enters standby mode. In standby mode, the MS station wakes up only during those slots of the control channel CCH superframe which have been assigned the role of paging channels PCH in order to monitor whether it is being paged by the base station BS for a packet or voice transaction.

A packet transaction can be either initiated from the mobile station MS ('mobile-originated transaction') or initiated from the base station ('mobile-terminated transaction').

A mobile-originated packet transaction is initialised as follows. The mobile station MS synchronises to one of the dedicated user packet channels UPCH in the downlink (as previously decoded from the BCCH information). Via the corresponding uplink slot, the mobile station MS makes a request for packet communication. As part of the request the mobile station MS indicates whether it is seeking a high or low speed packet channel and whether it is capable of supporting full duplex communication. In a high speed packet channel, 2 or 3 slots (0..2) of the

3-slot frame allocated for the user packet channel UPCH are used to carry packet data ('multi-slot'). In a low speed packet channel, a single slot of the frame allocated for the user packet channel UPCH is used to carry packet data ('single-slot'). Via the assigned downlink slot, the mobile station MS can receive approval for either a multi-slot or a single-slot channel.

A mobile-terminated packet data transaction is initialised when the mobile station MS detects that it is being paged via a paging channel PCH, as previously described. Thereafter, the procedure for initialising the transaction is the same as for the mobile-originated transaction.

Packet data is transmitted as a sequence of I-frames or layer 2 (of the standard OSI seven layer model) LAPDm units. As shown in Figure 3, each I-frame 50 comprises a head unit 52, an end unit 54 and any number of intermediate units 53. Each unit occupies a single slot of the user packet channel UPCH.

Figure 4 shows an example of a packet transaction in which both a multi-slot and a single-slot user packet channel UPCH format are employed.

Initially, in frames 0-4, the base station BS sends three I-frames $I_{d1}$, $I_{d2}$ and $I_{d3}$ via the downlink. The mobile station MS is not transmitting during this interval and is receiving in continuous reception mode (see section 4.1.10.2.2.2.2 of reference 1). $I_{d1}$ comprises a head unit 52, 2 intermediate units 53a, 53b and an end unit 54 and is transmitted on slot 0. $I_{d2}$ comprises a head unit 52, 1 intermediate unit 53a and an end unit 54 and is transmitted on slot 1. $I_{d3}$ comprises a head unit 52, intermediate unit 53a and an end unit 54 and is transmitted on slot 2. In these initial frames when packet data is being sent in one direction via the downlink, a multi-slot user packet channel UPCH format is employed - the maximum number of 3 slots per frame are allocated to carry packet data.

On slot 0 of frame 4, a unit 60 not destined for the mobile station MS appears and so gives the mobile station MS the opportunity to attempt uplink access. Because the uplink control channels, including the user packet channel UPCH, are common

access, a collision control mechanism (between the mobile stations) needs to be employed. The mobile station MS decodes (arrow 62) the idle/busy flag associated with slot 0 in the current frame of the downlink which indicates whether the corresponding uplink slot is currently in use. If it is 'idle', as it is in this case, the mobile station MS transmits on the corresponding uplink slot the head unit 52 of an I-frame $I_{t1}$. The MS station then waits on slot 0 of frame 5 for a response from the base station BS. The base station BS transmits a partial echo PE and a receive/not receive or R/N flag (arrow 64). The partial echo is a CRC check sum. If the partial echo PE matches that for the head unit 52 which was transmitted and the R/N flag indicates that the head unit 52 was successfully 'received', as it is in this case, the mobile station MS assumes that it has been allocated slot 0 for uplink transmission of further units of the I-frame $I_{t1}$ in subsequent frames and switches to a single-slot user packet channel UPCH format. On receiving a decodable head unit 52 from the mobile station MS the base station BS assumes that the mobile station MS has switched to a single-slot user packet channel UPCH format and acts accordingly. In the case (not illustrated) where uplink access is not gained, because of, for example, collision with another mobile station MS, the mobile station MS continues with multi-slot user packet channel UPCH format for the random retransmission interval specified in Figure 4.1.13.1-2 of reference 1. In subsequent frames, the intermediate units 53a, 53b, 53c and the end unit 54 of I-frame $I_{t1}$ are transmitted on slot 0. From frame 5 onwards, the downlink user packet channel is in single-slot format, whereby only slot 0 is used. At frames 5 and 6, an I-frame $I_{d4}$ comprising a head unit 54 and an end unit 56 are transmitted to the mobile station MS. Next on frame slot 9, an I-frame $I_{d5}$ comprising only a head/end unit 54/56 is transmitted to the mobile station MS.

It will be appreciated that the time offset between the uplink and downlink channels enables half-duplex communication to take place during the same logical slot via the uplink and the downlink, whereby a mobile station MS which is not capable of transmitting and receiving at the same time may be used.

In the Figure 4 example, the mobile station MS is receiving in continuous reception mode with a multi-slot user packet channel UPCH format. On switching to the

single-slot user packet channel UPCH format, the mobile station MS continues with the continuous reception mode. Similarly, the mobile station MS would remain with the same reception mode on switching between the multi-slot and the single-slot user packet channel UPCH format when the mobile station is initially in intermittent reception, superframe intermittent reception or hyperframe intermittent reception as defined in section 4.1.1.10.2.2.2.2 of reference 1.

It will be appreciated that because the format of the user packet channel is switched in the way described, a half-duplex mobile station is able, if circumstances permit (i.e. if no uplink communication is required for a given interval) to maximise the downlink throughput (up to 28.8 kbps), while still being able to cope, albeit at a lower data rate, with communication via both the uplink and downlink. Further, because the change in user packet channel format has effects which are confined to a given frame, full and half-duplex mobile stations can easily co-exist on the same network.

**CLAIMS**

1. A method of carrying out a transaction between a mobile station and a base station in a cellular radio system using communication channels comprising a plurality of time-division multiplexed frames, each frame comprising a plurality of consecutive slots, the method including the steps of :-

the base station performing downlink transmission in a first format of more than one slot per frame, and the base station performing downlink transmission in a second format of one slot per frame when the mobile station is performing uplink transmission in the second format.

2. A method as in Claim 1, wherein the base station switches from the first format to the second format to allow the mobile station to perform uplink transmission.

3. A method as in Claim 1 or Claim 2, wherein the mobile station initiates uplink transmission after the completion of a downlink transaction in the first format.

4. A method as in any preceding claim,

wherein the mobile station comprises

a transmitter for performing uplink transmission in the first format;

a receiver for performing downlink reception in the first or second format;

wherein, in the system, corresponding uplink and downlink slots are substantially spaced from one another in frequency and spaced from another in time by less than the duration of one slot, and

wherein the mobile station further comprises means to attempt uplink access via an uplink slot and verify uplink access by a message via the corresponding downlink slot.

5. A mobile station for performing the method according to any of Claims 1 to 3.

6 . A mobile station for a cellular radio system in which uplink communication is common access, comprising:

a transmitter for performing uplink transmission in a single-slot format;

a receiver for performing downlink reception in a single-slot or a multiple-consecutive-slot format;

wherein corresponding uplink and downlink slots are substantially spaced from one another in frequency and spaced from one another in time by less than the duration of one slot,

wherein the mobile station is able to initiate uplink transmission via an uplink slot and then verify uplink access by a message on the corresponding downlink slot.

The Patent Office

**Application No:** GB 9625538.5
**Claims searched:** 1 to 5

**Examiner:** Glyn Hughes
**Date of search:** 29 April 1998

# Patents Act 1977
# Search Report under Section 17

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): H4L (LDGP, LDGX), H4M (MN)

Int Cl (Ed.6): H04B 7/212, 7/26, H04J 3/16, H04Q 7/30, 7/32, 7/38

Other: Online: WPI

**Documents considered to be relevant:**

| Category | Identity of document and relevant passage | Relevant to claims |
|---|---|---|
| A | EP 0644702 A1 (ALCATEL-BELL) see whole document | - |
| A | WO 94/10767 A1 (ERICSSON) see page 6 lines 20 to 33 | - |

| | | | |
|---|---|---|---|
| X | Document indicating lack of novelty or inventive step | A | Document indicating technological background and/or state of the art. |
| Y | Document indicating lack of inventive step if combined with one or more other documents of same category. | P | Document published on or after the declared priority date but before the filing date of this invention. |
| & | Member of the same patent family | E | Patent document published on or after, but with priority date earlier than, the filing date of this application. |